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Establishing an Innovative Knowledge Community - a case study of (JEMES) a Joint European Master in Environmental Studies

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1. Introduction

The emergence of knowledge societies brings in new characteristics of knowledge construction and learning processes described by words like – technology-bound, multi-dimensional, unstable, innovative, collaborative and complex. Professional competences and expertise become progressively more difficult to identify when problems are becoming cross-disciplinary involving various integrated issues like technology, environment, economy, culture and sustainability. This gives rise to challenges to universities which traditionally have been discipline focused relying on a stable knowledge base and individual learning. Questions have been posed to universities like: how to help students gain contextualized knowledge and competencies which are connected with relevant cultural and collaborative environments instead of merely learning generalized and subject-oriented knowledge and fixed skills? How to prepare students for their professional life in the globalized society with sufficient readiness to solve the complex and ever-emerging new problems collaboratively and innovatively? How can students be equipped with appropriate lifelong learning skills through their university lives?

In this paper we reflect on these questions through examining an innovative educational practice in the Erasmus Mundus consortia JEMES (Joint European Master in Environmental Studies), with four partner universities in Europe: Aalborg University, Denmark, Hamburg University of Technology, Germany, Autonomous University of Barcelona, Spain, and University of Aveiro, Portugal. The students in JEMES are mostly students from outside EU, funded by the EU. In 2007, 25 students were offered a grant.

In this paper we set out to investigate some of the experiences from the first cohort of students involved in the programme in September 2007. These students met with some of their teachers in a meeting in Hamburg Technical University in May 2008. To gather the first impressions from the students a questionnaire was made

supplemented by videotaped interviews. The results of preliminary findings of this investigation, aiming primarily to describe the students experiences from studying in Europe, in an intercultural setting, and being exposed to different learning styles will be reported in this paper.

2. Putting JEMES into context

In 2006 JEMES was awarded the Erasmus Mundus title as a new consortia of universities working together to provide a joint study programme within the field of environmental sciences (Joint European Master in Environmental sciences). The consortium consists of 4 universities; Autonomous University of Barcelona (Spain), Averio (Portugal), Technical University of Hamburg (Germany) and Aalborg University (Denmark). These 4 universities have previously worked together in the European consortia of innovative universities (ECIU). In 2007 the first generation of students began on the programme. The JEMES curriculum is based on a high degree of mobility. The students must be at either 2 or 3 different universities through the master programme which is designed to comprise 4 semesters or 120 ECTS.

Purpose of JEMES

JEMES is particular in its interdisciplinary character, the close link between practical and theoretical components, the project character of many courses, the research-based thesis, and the "shift of perspective" all students have to undergo during training.
In its two streams, Environmental Technology Engineering and Environmental Management Engineering, JEMES interweaves technological and management education, research-based courses and intensive practical exercises on a high academic level. Students start in one stream, do the second semester in the other and then decide in which direction to specialise. The last semester is entirely devoted to thesis research.
Students will obtain a Master of Science degree in Environmental Studies jointly awarded by all universities. The joint Degrees will be recognised in all partner countries. Training will provide students with a solid and broad scientific background in the field and important abilities and qualifications such as problem solving, teamwork, management of complex environmental processes, analytical competency, not to mention high intercultural awareness and excellent communication skills, fluency in English and knowledge of other European languages, a network of valuable contacts.

Box 1 Purpose of JEMES (information see http://www.tu-harburg.de/jemes/)

The aims of JEMES can be seen in Box 1. In the creation of JEMES it was decided to create something new and different. It was needed to respond to new the new approaches to environmental protection that had emerged in the 1990s in particular, the shift toward so-called preventive measures both in environmental management and technology. These issues as well as related topics (such as the interaction between international trade and the environment, global equity and ecological citizenship, technology transfers, environmental justice, access to resources), all fall somewhat outside of the established environmental higher education curriculum. A list of issues JEMES have tried to include is:

- Sustainable development
- Climate change
- Environmental technology and engineering
- International trade / North-South relations
- Environmental governance

Most of these issues require for their understanding a "transdisciplinary" type of knowledge with theories, concepts and methods that are drawn from a number of different fields. In the JEMES programme we have found it crucial to combine perspectives from the natural and technical sciences with approaches from environmental planning and management. The general idea is to integrate an environmental concern into all activities. Many organisations and companies have felt a strong pressure to adapt their activities towards a more sustainable approach. There has been a range of new programmes and initiatives in such areas as environmental management, cleaner production, green procurement, industrial ecology, green product development, which require new forms of expertise and thus present a challenge to institutions of higher education to develop new kinds of educational curricula (1).

In JEMES a number of the new approaches to environmental protection have been included, such as:

- Greening of industry
- Environmental management
- Public participation / Stakeholder involvement
- Cleaner production / Life cycle assessment
- Environmental engineering

The new environmental agenda has already had a major impact on the labour market. In recent years the job opportunities for those with an environmental education have tended to spread from public to private sector but also to the non-governmental organisations. The qualifications required for many of the jobs in this emerging labour market are somewhat different from those that have characterised the environmental professions globally up to now. New interdisciplinary skills are required, which we have tried to establish in the curricula offered by the consortium.

The 4 universities have different profiles so it was decided to make two streams, one in environmental technology engineering (Hamburg and Aveiro) and one in environmental management engineering (Barcelona and Aalborg). When applying for the programme the students decide which stream to be in by the University they choose. Starting in Aalborg implies that the student is devoted to the environmental management stream. The following semester the students as a general rule must change stream, i.e. if coming from Aalborg University they have to choose between Hamburg or Aveiro for the more technical stream. The third and fourth semester the students return to their stream but then have to decide which of the two universities within the stream they favour.

The students in JEMES are mostly students from outside EU. As a major part of the programme EU donates grants for overseas students. 25 students were offered a grant in 2007. Students from Europe can also take part in the programme, but as there is a consortia fee of € 3000/year to be paid by the students we don't see many European students enrolled as they, literally speaking, can follow the same university programmes for free, even going abroad for a semester or two as Erasmus students.

All in all the 4 universities offer a very large variety of courses and topics, from environmental sciences, over environmental engineering to environmental management and ecological economics. This gives the students a good opportunity to follow their specific interests composing a programme that suit their individual needs.

Furthermore the 4 universities are inherently different in terms of approaches to teaching and in teaching styles. When it comes to learning styles the students face many different models and approaches.

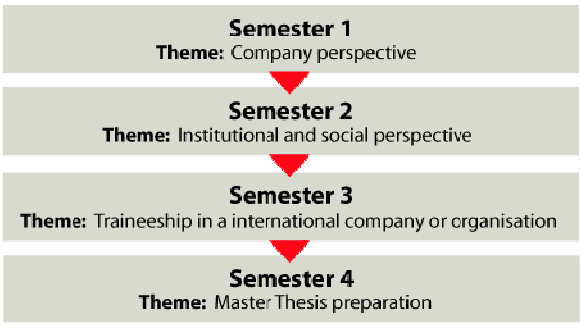
Box 2 shows the Master program of Environmental Management at Aalborg University. More information can be seen in the website: http://www.environmentalmanagement.aau.dk/

The Master of Science Program in Environmental Management at Aalborg University

The Master of Science Program in Environmental Management at Aalborg University is directed at science and engineering students who are interested in topics related to sustainability and environmental management. In the two-year MSc programme (120 ECTS), Danish and foreign students are mixed and the programme is of course taught in English. Out of approximately 30 students a year, 25-50 percent are Danish and have mostly all followed the undergrad studies of Planning & Environment (cf. http://www.planogmiljo.dk/) or Environmental Engineering (http://www.bio.aau.dk/en/environmental_eng/), while the remaining are from all over the world and with a quite varied mix of engineering or science undergrad degrees. The program is designed to meet these new challenges, by integrating inputs from the social and human sciences into the study of planning and engineering. The focus is on how firms, governments, and other organizations can support sustainable development in an economically efficient and socially acceptable manner.

The Master of Science Programme in Environmental Management combines a theoretical orientation with practical project work. This means that you achieve hands-on experience with a range of practical techniques in such areas as environmental planning, environmental policy, environmental management systems (EMS), corporate social responsibility, logical framework analysis, life cycle assessment (LCA), and energy analysis and planning. You will be able to use different tools for project design, environmental monitoring, quality control and evaluation as well as planning. Furthermore, you will be trained in using cost-benefit and cost-effectiveness methods. The programme will also provide you with an understanding of the social and political implications of planning and management within the environmental field. This includes an understanding of the relationships between companies and stakeholders, the environmental challenges facing businesses operating on international markets, and an introduction to various types of environmental regulations. These are just some of the topics that are integrated in the Master of Science Programme in Environmental Management.

Here you can see the structure of the Master of Science Programme in Environmental Management.



Box 2 Master in Environmental Management at Aalborg University (http://www.environmentalmanagement.aau.dk/)

In Aalborg the curriculum is based on problem-based learning in project groups (see box 3) while the model in the other three universities is more in line with traditional courses although many experiments with group work and smaller problem-based assignments are developed. This way of teaching and learning has been well-recognized as an efficient way of educating engineering and science students who have sufficient skills to meet the need of the industry and the life long learning strategy [2]. It has also been documented as a successful pedagogy for sustainability and environmental management [3].

At Aalborg University in general, the key concept in both research and education is innovation. In particular, the teaching and learning methods – Problem and Project Based Learning (PBL), which is rooted in a pragmatic approach to educational

innovation, has been well implemented and sustainably developed. In brief, the fundamental elements of AAU-PBL are:

- The semester **theme** that can describe certain problems and cover relevant subjects.
- The **problem** as a starting point for a project that can vary among professional areas.
- The choice of **projects** that can be based on open or rather controlled discipline formulations depending on the educational objectives. In comparatively more narrowly defined or subject related projects, the facilitators make the preparation by defining the frame of the projects within certain subjects. The open projects are the 'real problem based' projects that start with students' own formulation of problems and can be highly interdisciplinary.
- The **team work** that will encourage students to develop process skills such collaboration, management of learning and peer learning.

The curriculum is organized into semesters – each semester lasts approximately 5 months and there are altogether 10 semesters leading to a Master's degree. Each project is organized in a deterministic structure with a well-prescribed output. In order to pass each semester, students are expected to conduct a project and earn 30 ECTS (European Credit Transfer System). As Figure 2 shows, approximately half of the students' time is spent on project work (which takes up 15 ECTS) in teams, whereas the other half is spent on traditional lectures. The lecture part falls into two types: project related courses (which takes up approximately 7.5 ECTS) that are designed to support project work and are examined through project reports and oral defence, and study courses (which normally takes up 7.5 ECTS) that cover basic skills such as mathematics and physics, and are examined as single subjects through traditional ways such as written exams. The projects are formulated within the framework of the given theme and related to the overall educational objectives. Each team works on a unique project. Very often students formulate their project proposal with the help and approval of the facilitator.
The AAU - PBL practice is characterized by a combination of teaching and learning methods. Learning resources include lectures, facilitation, companies, lab, experts, sharing information with other groups, etc. Nearly all project work is made in self-formed teams. Team size varies from normally 6-7 students in the first semesters to 2-3 students in the semesters. Students are supposed to attend the courses and apply them in their project work.
Each group has one or several facilitators (teaching staff). The roles of facilitators vary during the project process. Before the semester starts, facilitators will make preparation for project proposals and plan project related courses. At the beginning of the project, they provide guidance to students in terms of literature, theories, and methods as well as help on contact with companies and other resources in order to put students on the right track. During the project itself, their role will shift into one of consultancy and, instead of giving direct guidance; they mainly provide comments to students on their work and monitor the project development. At the end of the project, they will read the project report and chair the examination together with an external/internal examiner. The project examination is a joint group examination with individual marks.

Box 3 PBL at Aalborg University [4]

This gives the students a good opportunity to follow their specific interest composing a programme that suit their individual needs. These four universities have decided that credit transfer is always given to students following the streams in the projected manner, thus being eligible for receiving a joint degree.

3. Research methods

An educational research project started in the middle of the second semester of JEMES program, with an aim of understanding students' study experiences. A workshop was held at the end of May, 2008 in Hamburg with the participation of nearly all students and representatives from each of the partner universities. This research will follow the following stages of the JEMES program in order to examine in which ways and to what extent it functions as innovative knowledge creation and learning community for students to learning at both global and local levels. The main research methods are: 1) qualitative interviews with students as well as involved staff during the workshop, 2) questionnaire-based survey to all students, 3) documents and 4) observation from teaching experiences.

This paper will present and discuss the preliminary findings from the first stage of this study. The data are mainly from interviews during the workshop as well as observation from teaching experiences. Qualitative interviews were carried out with 20 students, from the four partner universities, who come from diverse ethnical culture backgrounds. Interviews were conducted in focus groups which were formed based on where they

studied the first semester. The workshop was scheduled to last two days. The first day started with staff meetings and discussions in the morning, and meetings with students in the afternoon, where students were provided with information concerning each university which aims to help them make a choice on the third and fourth semester. Agenda for the second day was focused on dialogues between students and staff concerning how to improve the future activities in the JEMES program. Interviews were conducted during meeting intervals. They were semi-structured and video taped with permission. Interview questions focused on three main areas: 1) students' backgrounds, reason for choosing JEMES and semester venues. 2) Learning experiences concerning the contents, curriculum, teaching and learning methods, intercultural and interdisciplinary perspectives, etc. 3) challenges and difficulties.

4. Empirical findings and discussion

Students' backgrounds and reason for choosing of JEMES

This group of students has diverse backgrounds in terms of ethnical culture and education. They come from more than 10 different countries like Spain, France, Germany, Austria, China, Lebanon, Ethiopia, Ghana, Vietnam, Indonesia, Serbia, Canada, India, etc. They also have different disciplinary backgrounds from civil engineering, chemical engineering, environmental engineering, electronics engineering, biology, management, economics, and so on. This high diversity makes JEMES a multicultural and multidisciplinary environment.

There were two major ways for the interviewed students to reach information about JEMES: 1) recommendation from friends who already studied in Europe; 2) JEMES website. Major reasons for their choice of participation in JEMES can be listed as follows:

- Interest in the contents of the program – combination of technical part of environmental engineering and management perspective, and combination of different hot issues in this area like climate change, and sustainable development, etc.
- Mobility is another reason that makes this program interesting. In particular, non-EU students appreciated the opportunities of studying in different European universities with scholarship.
- International program where they can expect rich cultural experiences.

Information on JEMES mainly came from two resources:

- Friends' recommendation – inspiration from friends' good experiences of studying in other joint EU programs.
- Internet – result by random search or by looking for EU programs in general.

Reasons for choosing the place for the first semester varied and generally fell into 3 types.

- The first type: for those who were rather clear about their whole study plan, they made the choice based on the focus of the provided curriculum (for example, environmental management or technical contents in engineering). For example, if they want to focus on technical contents in their final thesis, they might choose the university where they can learn management as a start and move to another one in the second semester.
- The second type: those who did not have a clear plan made a random choice.

- The third type: those who made the choice based on their interest in the venue, for example, the city of Barcelona is an attraction itself.

Learning experiences

Interview data showed that students had different learning experiences in the four universities due to the diversity of the curriculum organization, teaching methods and learning culture, institutional and social culture of the venue, and the personalities of the teaching staff.

Curriculum

In general, most students found the organization of curriculum interesting and useful. In particular, those who experienced UAB and AAU talked about the benefits they gained from studying environmental issues with a management perspective, as one student said,

> *'This cross-disciplinary experience opened up my eyes and mind. I used to look at the environmental issues from technical perspectives and try to find technical solutions. Now I know that it is not enough…I start to look at these issues from a new way. I am more and more interested in the topic and would like to devote myself to working on this area in the future…'*

Teaching and learning methods

Different teaching and studying methods made the students' learning experiences different as well. Those who studied in TUHH find it strict, disciplined, and technically focused in the learning culture. Those who studied in AAU specially mentioned the unique experiences of studying in the Problem Based and Project Based Learning environment. Based on the students' reflection as well as the authors' teaching experiences, the students' experience of going through a project can be described as following:

The JEMES program is integrated into the average Master program at AAU, with the intention of facilitating JEMES students to communicate and collaborate with all the Master program students.

At the beginning of each semester, students form project groups based on their shared interests in solving professional problems. To get the project started, students need to search for the information on the background and context, to find relevant literature, to read theoretical articles, to discuss with supervisors or people who know the area, and they might also need to contact industries or companies for interviews or observations to gain field knowledge. When they have collected sufficient materials, they start to analyze the contextual situation and formulate the problem. The next stage is to find out how to solve the problem and choose one of the solutions in relation to the given context, and this involves the same procedures of searching, reading, discussing and writing. During the semester, students are facilitated with the knowledge from the literature, lectures, and supervision; however, they are expected to relate these different knowledge resources to their project. They need to develop different strategies to gain theoretical knowledge, methods, and context knowledge in order to solve the problem, which very often requires a process of integrating knowledge from different disciplines and relate them to practice.

Instead of following the procedures designed by the teachers, students are expected to manage the project planning on their own. To make a project efficiently, students need to divide the work into different tasks. Therefore, group work incorporates individual work, working in sub-groups and working in the project group. Many groups put both long-term (normally a semester, for the whole project) and short-term plans (either one week or two weeks) on the wall in their group room. For the long term plan, they signify some milestones in a semester calendar, which might be kept flexible for modification along the way. For the short term plan, students very often make 'to-do' list each day or each week. This process involves developing skills in plan-making, agreement-achievement, work-division, cooperation and communication. Social and communicative skills played an important role on building up a supportive and motivating atmosphere, which could lead to effective learning. Peer learning through working in groups can be rather constructive by providing mental support as well as developing responsibilities.

Table 1 shows an example of a student project work at the first semester of the international master program. In this project, 3 out of the 5 group members were JEMES students.

The Green Martin Projects (group 1 report)	
Context and aims	Martin Professional, a producer of intelligent lighting systems seeks to develop a green profile. This project seeks to identify the aspects of Martin's activities and products that impact the environment as well as the gaps existing between Martin's present environmental work and the ISO 14001 requirements.
Research question	What are the gaps between the current environmental work of Martin Professional and the ISO 14001 standards and what are the potentials and barriers for reducing the significant environmental impacts of the company's activities and products?
Theories	The step model, Environmental Management Systems (EMS),
Research methods	Qualitative approach for data generation – interviews with the company's representatives, on-site tour of the company, literature review of relevant materials from internet sources, scientific journals. Analysis of interview, Analysis of selected products by Sima Pro tool, Analysis of gap analysis questionnaires.
Results	Martin's activities impact the environment adversely predominantly through the factory's total energy input, emissions to air and even most importantly through the energy consumed in the use stage of the products. Other less significant environmental impacts identified related to hazards, waste, water consumption and nuisances. Compared to the ISO 14001 requirements, the company was found to possess an environmental policy, and had also done some work in relation to operational control and emergency preparedness and response. It however fell short of about approx 90% of the requirements of the ISO 14001 standards.

Table 1: An example of student project work at AAU

Coming from a different learning environment in their previous school experiences, these students found it challenging to study in the learning environment at AAU, which highlights problem-solving skills, critical thinking, active learning, self-directed learning, self management, collaborative learning and the aligned examination systems. This experience is shared by most of the interviewed students, which encourage the students to develop different new learning strategies. One student reflected,

> *'I think that one of the best thing I gained here is the Problem Based and Project Based Learning. I used to work as a teacher before I joined JEMES. It is normal to just to give big lectures…now I realized that how boring it was…after my graduation, I will go back to my home country, in addition to bring back all the new ideas I learned in environmental management area, I would also like to bring back this PBL methods for teaching…'*

Through the project work, students felt that they fulfilled the overall learning goals, which include 1) understanding of the leading theories and practical experiences within Environmental Management; 2) capability to define and solve environmentally related problems in the business world as well as in public organizations and the broader society.

Communication and collaboration in an intercultural context

Both interview data and observation from teaching experiences show that studying in an international program, the learning process is not only a process to gain skills of working with/on technology, but also a social process developing skills of collaboration, communication and productive working with knowledge.
Knowledge sharing and cooperation can be difficult for students from backgrounds where individual competition was highly encouraged. The experiences of working on projects which are related to companies provide a live picture of work life to these groups of students, as some of them reflected, 'engineering work can not be done by individuals, therefore we have to work together'. With this new perception, they are motivated in learning how to collaborate. As one group of students discussed,

> *'This is a very efficient way of learning. We share information and work together. But it was not easy at the beginning, since we were not sure what we should tell each other, and what we should not, we had different knowledge background…'*

Social activities like eating and drinking beer together also played an important role in improving communication. Throughout the interview, all of the students mentioned their achievement in terms of improving communication skills as one important learning outcome from JEMES.
Both interview and observation findings show a strong indication of how culture plays a role in the communication process. Certain cultural patterns were recognized by all the students through working together in both forms of communication. Students recognized visible differences in the ways of making themselves clear, interpreting others' ideas, working styles like planning, structuring, organizing work and writing report, which give rise to challenges for reaching consensus. However, this turned out to be a good learning process, as some of them reflected, it helped to know more about other cultures than one's own, and rethink what has been taken for granted in terms of working styles, perspectives, values and so on. In addition, it is a lot of fun to study in the international environment, which was generally regarded as one of the most valuable experiences in JEMES.

Challenges and issues

Through the analysis of the preliminary findings, this research identified the following challenges for the JEMES program.

- Communication in a multicultural and multidisciplinary context: differences arising from students' cultural and discipline background may increase the diversity of good ideas, inspiration, and contribution. However, it is also challenging in the sense that it makes students' level different, which in turn

sometimes makes communication and arrangement of teaching contents difficult. Therefore to which level the diversity of the students' backgrounds can be / should be framed became an issue that remains in debate.

- Integration between the international and local – although students had different experiences with the level of integration with the local program, they all agreed that the benefits of JEMES participation will be maximized with higher level of incorporation with the local both academically and socially.
- Administrative issues: difficulty in mobility due to the overlap between universities in semester time tables and need for more administrative help with accommodation, visa application, bank account, etc.
- Validation and recognition of the mobility activities after graduation.

These challenges make it difficult to reach consensus in the JEMES program; however, taking the challenges will help match the students' need and develop sufficient potentials.

5. Conclusion

In this paper we discussed that the practice of JEMES so far has reached its aims in a positive way. By bringing scholars and students from all over the world together in a challenging but interesting international study programme, as all the interviewed students mentioned, JEMES has been functioning well so far. This to a certain level matches its intention - to produce European and overseas environmental specialists with capabilities in innovative technologies and management strategies. In order to provide real-world experience and profound research knowledge, the JEMES programme establishes interdisciplinary and intercultural learning contexts, which to a great extent help the students to gain the capabilities of handling the complexity of environmental problems. For the students this has been a positive experience for their personal development towards becoming proficient professionals. The challenges and issues remaining require further efforts to make best use of the resources and develop the potentials of students to become innovative graduates who can successfully manage all major aspects of their professional field and have an extensive overview of new developments and future trends in the area.

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